18

TOBACCO RESEARCH AT THE EASTERN REGIONAL RESEARCH LABORATORY

By E. G. Beinhart, *Senior Tobacco Technologist*

and

J. J. Willaman, *Chief, Biochemical Division*

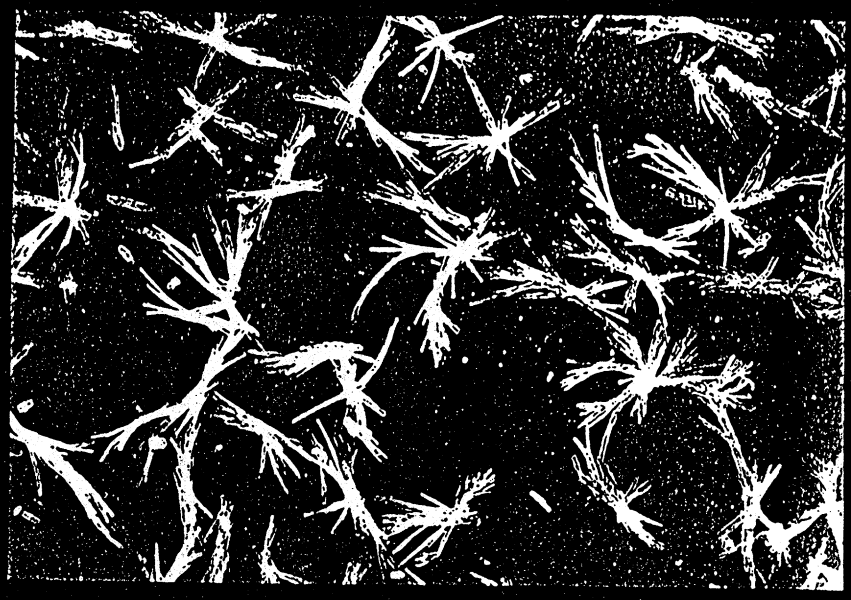
EASTERN REGIONAL RESEARCH LABORATORY, BUREAU OF AGRICULTURAL CHEMISTRY AND ENGINEERING, UNITED STATES DEPARTMENT OF AGRICULTURE, PHILADELPHIA, PENNA.

THE program on tobacco utilization being conducted at the Eastern Regional Research Laboratory includes experimental laboratory and pilot-plant work, intended to develop new and wider uses for nicotine, and fundamental studies of the various factors, other than agronomic ones that influence the quality and use of leaf tobacco and its products. Both lines of investigation are directly concerned with phases of the surplus problems of the domestic tobacco growers.

Nicotine has been an important insecticide for many years. It is derived from tobacco factory by-products such as stems, scraps, and other factory offal, and to a lesser extent from low grade leaf of the heavy tobacco types. Approximately 75,000 tons of factory wastes developed annually yield nearly 800,000 pounds of the alkaloid. An additional 200,000 pounds of the alkaloid are secured from low grade leaf tobacco, although this amount varies from year to year, and is dependent upon the market conditions for such grades.

It has been suggested that the tobacco industry effect arrangements whereby the lowest grades of tobacco may be diverted directly into by-products channels and remove them from competition with the common and low medium grades of leaf tobacco. Such removal of low grades should enhance the value of the remaining grades offered.

In the past about 75 per cent of the production of these tobaccos have been exported, but in recent years the producers have suffered heavily due to loss of important foreign markets. In 1923, the United States exported 210,000,000 pounds of these types. These substantial exports had declined in 1938 to 60,000,000 pounds and in 1940 to only 33,000,000 pounds.



CRYSTALS OF NICOTINIC ACID—VITAMIN P-P

Vitamin P-P (Pellagra Preventive) is used in pellagra therapy. It recently was recommended to be added to white flour to fortify the nation's diet. Chemists at the Eastern Regional Research Laboratory are making every effort to perfect the use of nicotine for making this vitamin. If all of the nicotinic acid required by the United States in 1941 were made only from nicotine, 17 to 20 millions of pounds of tobacco would be required.

(*Photomicrograph courtesy of Merck & Company*)

A Replacement "Industrial" Tobacco Crop

The producers of these types have been unable to readjust their farm economy rapidly enough to meet the changed conditions. Their soils are not adapted for the production of other types of tobacco, and in many instances they have been unable to find replacement crops for their idle tobacco acres. With the decline in export sales there has followed a general decline in their price structure necessitating substantial aid by government lending agencies to support the markets.

The producers' situation might be improved (1) by removing the lowest grades into by-products channels and taking them out of competition with the medium grades; (2) by growing *Nicotiana rustica* (a high nicotine producing species) as a replacement crop on the tobacco acreage now idle.

The production of *Nicotiana rustica* has been attempted experimentally in various parts of the United States since 1911. None of the previous projects were developed commercially because of the higher return per

chemical industry unprepared to supply the large quantities suddenly demanded by the flour millers and bakers.

The three best known compounds from which nicotinic acid may be derived by oxidation are nicotine and two coal-tar products, quinoline and beta-picoline. While nicotine is the most costly source of the three, it appears to offer certain advantages in simplicity of manufacture and in purification of the reaction products. Nitric acid is the simplest reagent, known at present, for oxidizing nicotine to nicotinic acid; for oxidizing the two coal-tar products, potassium permanganate is preferred. It is becoming increasingly difficult to obtain this latter reagent in the large amounts now required, and others are more difficult to handle. Quinoline is a staple chemical product easily procurable at relatively low prices. Beta-picoline has not yet been produced in sufficient volume in the chemically pure grade to assure its dominance of the nicotinic acid field that the simplicity of its reaction might indicate. At the moment, the 200,000 pounds of nicotinic acid estimated to be required in 1941 for the breadstuffs industry alone represents nearly 500,000 pounds of nicotine alkaloid—by far the largest single new use that has ever appeared in the nicotine industry—which is equal to at least one-half the present consumption of nicotine for all uses.

The problem is an intriguing one. While cursory study reveals most of the advantages are with the coal-tar products, there appears on closer examination the possibility of developing methods of oxidizing nicotine at a cost that will make it competitive with the coal-tar products. It is a challenge to the nicotine chemist. This large demand for nicotinic acid fulfills the requirements for new and required products of wide consumption which do not compete with other products already established.

Other Problems

There are many important problems confronting chemists concerned with expanding the uses of tobacco. For example, the elements of tobacco quality are important, those that add to the smoking quality and those that detract. Chief among the latter group are certain irritants that often occur in cigar tobaccos. It is planned to study these irritants in the hope of finding means to remove them by processing methods, and thereby expand the consumption of domestic cigar tobaccos.

Study of the alkaloids other than nicotine, such as Novnicotine, is opening an interesting field, especially from the insecticide standpoint.

The present relatively high cost of nicotine, to be sure, often stands in the way of its more extensive use. However, research is underway to determine if the cost of nicotine can be reduced by development of more efficient methods of extraction. In line with this, the study of activators to enhance the effectiveness of nicotine as an insecticide is of considerable

interest. The development of materials that will make nicotine go farther, which would be equivalent to reducing cost, should encourage more extensive use, and thus enlarge the market for this valuable insecticide.

All of the important lines of research outlined herein are directed towards wider utilization of domestic tobaccos. It is hoped that early results will help one important branch of American agriculture to carry on profitably during the present era of kaleidoscopic changes.

PROFESSIONAL DIRECTORY

cre that could be obtained from other crops. Now, however, under crop production adjustment programs, the producers of the heavy tobaccos have idle tobacco land and are without a replacement crop that promises an income commensurable with that available from rustica. Soy beans, lespedeza for seed or hay, truck crops and small fruits and other crops have been suggested for these idle acres but all of these crops come into direct competition with similar crops now being grown in the same or in other areas. Rustica does not compete with any other crop. It offers a small money income for acres that otherwise might yield no return to the farmer.

In 1940 three growers cooperated with the Laboratory and allied agencies in the experimental growing of rustica in Montgomery County, Tennessee. In 1941 under the direction of County Agent H. E. Short of Clarksville, Tennessee, 100 farmers are growing 60 experimental acres of rustica, and a nicotine manufacturer has agreed to purchase their crops. Should this experiment be successful, a new money crop will have been developed for several thousands of acres of idle land.

Fixed Nicotine

Fixed nicotines are a rather recent development and promise to greatly expand the market for nicotine, since they are effective against a larger group of insects. Prior to 1928 nicotine was used only as a contact insecticide and thus was restricted in its use to "sucking" insects. For such purposes it was applied as a spray or vapor and thus was quickly dissipated. In the "fixed nicotines" the alkaloid is available as a stomach poison. Combined in this way the nicotine is in a more permanent form and may persist on the foliage or fruit for as long as 15 days. The fixed nicotine can be used for control of certain of the "chewing" insects such as the larva of the codling moth (the worm in the apple).

The fixed nicotines now in use are equal to arsenate of lead in the control of the codling moth, but the cost of such nicotine sprays is at least twice that of arsenate of lead. However, residues from nicotine sprays as now prepared require for their removal only wiping of the fruit, instead of the extensive washing usually required to remove lead arsenate. They have a further advantage over arsenate of lead and certain other poisons in that the foliage of the trees is not injured, which tends toward an increased yield of larger and better colored fruit. The annual consumption of the alkaloid in the form of nicotine bentonite compounds (farm and factory preparations) has steadily increased from 400 pounds in 1936 to an estimated 100,000 pounds in 1941. The Eastern Regional Research Laboratory is endeavoring to develop fixed nicotine sprays which will persist on the trees for a longer time than do the present available compounds, and which will cost the grower but little more than arsenate of lead.

Several fixed nicotine compounds are now being studied whose properties appear to meet the growers' requirements, which are (1) high lethal action, (2) persistence on the fruit and foliage, (3) minimum of non-poisonous residue, (4) safety to operator, (5) simple formulation, (6) low cost, and (7) compatability with fungicides.

Nicotine Dusts

Another outlet for nicotine of considerable volume is found in the commercial vegetable crops, especially canning peas. The pea aphis is often a serious pest and in certain seasons it can be a limiting factor in production unless adequate provision is made for its control. Nicotine-lime dust, liberating free nicotine on exposure, has long been a standard insecticide used for the control of this pest. In recent years, however, rotenone preparations have found a wider use for this purpose because of their effectiveness over a period of several days.

One of the projects of our laboratory is to develop a new type of nicotine dust; one which will release part of its nicotine immediately and the rest over a longer period than is possible with present formulae. The larger portion of the nicotine in such a compound should become available within a period of 72 hours and be as effective as the rotenone materials. If such type of dust can be successfully formulated a very important market for nicotine can be retained and possibly expanded.

Nicotinic Acid

Obviously, it is difficult for chemists to evolve a "new" product from a farm crop that will fill a large need of the community or find use in industry, without displacing an established product. However, that is the ideal type of product that the research workers of the Regional Research Laboratories are especially interested in developing and, at the moment, nicotinic acid appears to meet all of the requirements of such a product.

On January 29, 1941, the Committee on Food and Nutrition of the National Research Council, in a report stressing the need for a better understanding and consideration of the Nation's nutritional requirements, recommended that white flour be fortified by the addition of assimilable iron, vitamins B_1 (thiamin chloride), and nicotinic acid. Prior to 1936 nicotinic acid was a laboratory curiosity. Following the classical experiments of Goldberg, Elvehejm, and others, announced in 1936, nicotinic acid received world-wide recognition as a medicine for the control of pellagra. In 1940 perhaps 10,000 pounds of nicotinic acid was manufactured for treatment and prevention of pellagra. It is estimated that 200,000 pounds will be required in 1941 for flour fortification and that the requirements for use in pellagra therapy may reach as much as 20,000 pounds. The new use of nicotinic acid for flour fortification found the